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Indications and Spectrum of Radiological Findings on Intravenous Urography in a Resource-Limited Tertiary Hospital in Northwest Nigeria: A Six-Year Retrospective Study

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ABSTRACT

Intravenous urography (IVU) remains an important imaging modality in many resource-limited healthcare settings despite the increasing availability of computed tomography urography and other advanced cross-sectional imaging techniques. This retrospective analysis evaluated the indications for IVU and the spectrum of radiological findings among patients who underwent the examination in a tertiary healthcare facility in Northwest Nigeria. A hospital-based retrospective descriptive analysis was conducted at the Department of Radiology, Federal Medical Centre Birnin Kebbi, now Federal Teaching Hospital Birnin Kebbi, Nigeria. Records of 285 patients who underwent IVU between January 2019 and December 2024 were reviewed. Demographic characteristics, clinical indications, and radiological findings were extracted from archived radiology records and analysed using SPSS version 22. Ages ranged from 1 to 70 years, with a mean age of 35.8 ± 14.6 years. Males accounted for 204 (71.6%) patients. The commonest indications were suspected urinary tract obstruction (33.7%), suspected urinary calculi (24.9%), and haematuria (15.4%). Hydronephrosis (27.4%), urinary calculi (22.5%), and hydroureter (13.7%) were the most frequent findings. Significant associations were observed between sex and urinary calculi ($\chi^2 = 4.43$, $p = 0.035$), clinical indication and hydronephrosis ($\chi^2 = 33.01$, $p < 0.001$), clinical indication and urinary calculi ($\chi^2 = 25.81$, $p < 0.001$), and mean age and urinary calculi ($t = 2.31$, $p = 0.022$). IVU remains valuable in resource-limited settings, particularly for obstructive uropathy and urolithiasis.

Keywords: Intravenous Urography; Radiological Findings; Hydronephrosis; Urolithiasis; Retrospective Study; Nigeria

INTRODUCTION

Intravenous urography (IVU), also known as excretory urography, has historically been an important imaging modality for evaluating the urinary tract. By providing information on both urinary tract anatomy and renal excretory function, it has been widely used in the investigation of urinary tract obstruction, urolithiasis, haematuria, congenital anomalies, and other urological disorders (Dyer *et al.*, 2001). For many years, IVU served as the standard radiological examination for urinary tract diseases.

The advent of advanced imaging technologies has transformed the evaluation of urinary tract pathology. Computed tomography (CT), magnetic resonance imaging (MRI), and high-resolution ultrasonography now offer superior diagnostic accuracy and have largely replaced IVU in many developed healthcare systems (Cowan, 2012; Silverman *et al.*, 2009). In particular, CT urography has become the preferred imaging modality for the assessment of haematuria, urinary tract obstruction, and urolithiasis because of its high sensitivity and ability to provide comprehensive anatomical evaluation (Abou-El-Ghar *et al.*, 2014; Cowan, 2012; Kawashima *et al.*, 2004). Current imaging guidelines also recommend CT urography for the evaluation of haematuria in appropriately selected patients, especially those at increased risk of urinary tract malignancy (Wolfman *et al.*, 2020). Studies comparing CT with IVU have consistently demonstrated superior diagnostic performance of CT in patients presenting with acute flank pain and suspected urinary stone disease (Chen *et al.*, 1997; Thomson *et al.*, 2001).

Despite these advances, IVU remains relevant in many low- and middle-income countries where access to advanced imaging modalities is limited by cost, inadequate infrastructure, and shortages of skilled personnel. Kawooya (2012) highlighted the continuing disparities in radiological service provision across sub-Saharan Africa and the consequent reliance on conventional imaging techniques. In such settings, IVU remains a relatively affordable and accessible investigation capable of providing useful anatomical and functional information. Although its role has diminished considerably, IVU continues to have value in selected clinical situations, particularly where comprehensive cross-sectional imaging is unavailable (Whitfield & Whitfield, 2006).

Urinary tract disorders remain a significant cause of morbidity worldwide and frequently require imaging for diagnosis and treatment planning. Obstructive uropathy, urinary tract calculi, congenital anomalies, and recurrent urinary tract infections are common conditions encountered in clinical practice. The burden of stone disease is particularly high in tropical regions, where environmental and lifestyle factors such as dehydration, high ambient temperatures, dietary habits, and recurrent infections contribute to its occurrence (Pearle *et al.*, 2005; Sorokin *et al.*, 2017).

Recent studies continue to demonstrate the diagnostic relevance of IVU in resource-limited settings. In Nigeria, Akagbue and Wekhe (2023) reported abnormal IVU findings in nearly 70% of examined patients, with hydronephrosis being the most common abnormality. Similarly, Umar *et al.* (2020) identified urinary tract calculi as the predominant abnormal finding, while flank pain was the leading indication for examination. Aklan and Mikhlafy (2018) also reported hydronephrosis and urinary calculi as the most frequent abnormalities detected on IVU, whereas Raza *et al.* (2011)

demonstrated a high diagnostic yield among patients investigated for urinary tract disorders. These findings suggest that IVU continues to provide clinically valuable information despite the increasing availability of CT-based imaging.

Although the role of IVU has been examined in several centres, data from Northwest Nigeria remain limited, particularly regarding contemporary indications for the examination and the spectrum of radiological findings encountered in routine practice. Similarly, a recent Nigerian review highlighted that medical imaging remains central to disease detection and clinical decision-making, although diagnostic services are often constrained by shortages of specialists and limited resources (Muhammad et al., 2026). Therefore, the present retrospective study evaluated intravenous urography examinations performed over a six-year period at a tertiary hospital in Northwest Nigeria, to determine the clinical indications for IVU and describe the pattern of radiological findings obtained. The findings are expected to contribute to the evidence base on urinary tract imaging and provide insight into the continuing relevance of IVU in resource-constrained healthcare settings.

MATERIALS AND METHODS

Study Area

The study was conducted at the Department of Radiology, Federal Medical Centre Birnin Kebbi, now Federal Teaching Hospital Birnin Kebbi, located in Birnin Kebbi, the capital city of Kebbi State, northwestern Nigeria. Birnin Kebbi lies approximately at latitude 12.45°N and longitude 4.20°E, with an estimated land area of about 1,037 km². The area has a hot semi-arid climate, with a distinct wet season and a prolonged dry season. The temperature is generally high for most of the year, while rainfall is seasonal. Birnin Kebbi serves as an administrative, commercial, and referral centre for Kebbi State and neighbouring states. The major occupations of inhabitants include farming, trading, fishing, and livestock rearing (National Population Commission, 2010; Weather Spark, n.d.). The hospital is a major tertiary healthcare institution that provides specialized diagnostic and therapeutic services and serves as a referral centre for Kebbi State and neighbouring states, including Sokoto, Zamfara, and Niger States. The Department of Radiology offers a wide range of diagnostic imaging services and receives referrals from primary, secondary, and private healthcare facilities across the region.

Ethical Consideration

Ethical approval for the study was obtained from the Health Research Ethics Committee of Federal Medical Centre Birnin Kebbi, with approval number (FMC/BK/HP/045/P/517/VOL.IV/016). As this was a retrospective review of existing records, patient confidentiality was maintained by anonymizing all extracted data and removing identifiers before analysis.

Study design and study setting

This was a hospital-based retrospective descriptive study conducted at the Department of Radiology, Federal Medical Centre Birnin Kebbi (now Federal Teaching Hospital Birnin Kebbi), Nigeria. The study involved a review of intravenous urography (IVU) examinations performed over a six-year period from January 2019 to December 2024.

Study Population

The study population comprised archived records of all intravenous urography examinations performed at the Department of Radiology, Federal Medical Centre Birnin Kebbi (now Federal Teaching Hospital Birnin Kebbi) between January 2019 and December 2024.

Inclusion Criteria

The study included archived patient results of intravenous urography examinations performed at the Department of Radiology, Federal Medical Centre Birnin Kebbi, now Federal Teaching Hospital Birnin Kebbi, between January 2019 and December 2024, with complete demographic, clinical, and radiological records available for review. Only archived IVU examinations with adequately documented radiographic images and corresponding radiological reports were included in the study.

Exclusion Criteria

Patient results were excluded from the study if their demographic or clinical information was incomplete, if the radiographic images or radiological reports were unavailable for review, or if the examination findings were inadequately documented, thereby preventing proper evaluation and analysis.

Sample Size

A total of 285 intravenous urography examinations that satisfied the eligibility criteria and had complete demographic, clinical, and radiological records were included in the study.

Patient Preparation and Procedure

All reviewed reports originated from standard clinical IVU examinations performed in accordance with institutional guidelines, which routinely included pre-procedural allergy screening, renal function assessment, standard bowel preparation, and informed consent.

All examinations were performed using a General Electric (GE) diagnostic radiographic unit (Model XR 6000; Serial Number SA20200013) and processed using a Carestream imaging printer. Images and corresponding reports were archived in the departmental records and formed part of the data reviewed during the study. The intravenous urography (IVU) examinations utilized a standardized multi-phase protocol consisting of a scout film, a 1-2 mL/kg contrast injection, and serial images ranging from the nephrographic to post-voiding phases. This routine sequence was designed to track contrast transit through the renal system, with delayed radiographs acquired for specific clinical evaluations.

All examinations were interpreted and reported by consultant radiologists in the department.

Data Collection

Data were extracted using a structured data collection proforma from radiology request forms, IVU registers, archived radiological reports and patient case records. Information obtained included age, sex, clinical indications for IVU and radiological findings documented by consultant radiologists.

Radiological findings reviewed included hydronephrosis, hydroureter, urinary calculi, delayed contrast excretion, congenital anomalies, non-functioning kidneys, filling defects and other urinary tract abnormalities.

Statistical Analysis

Data analysis was limited to information available in the reviewed records and archived radiological reports. Data were entered and analysed using Statistical Package for Social Sciences (SPSS) version 22. Descriptive statistics were used

to summarize demographic characteristics, clinical indications and radiological findings. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages.

Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test where appropriate. Independent sample t-tests were used to compare mean ages between groups. Statistical significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

A total of 285 patients underwent intravenous urography during the study period. The ages ranged from 1 to 70 years with a mean age of 35.8 ± 14.6 years. The highest proportion of patients was observed in the 31–40-year age group (26.0%), followed by the 21–30-year age group (23.9%). Patients aged 61–70 years constituted the smallest proportion (5.3%).

Table 1: Age Distribution of Patients Who Underwent Intravenous Urography

Age Group (Years)	Frequency	Percentage (%)
1–10	18	6.3
11–20	32	11.2
21–30	68	23.9
31–40	74	26.0
41–50	49	17.2
51–60	29	10.2
61–70	15	5.3
Total	285	100.0

The predominance of patients in the third and fourth decades of life suggests that urinary tract disorders requiring IVU are more common among economically productive age groups. This observation is comparable to findings reported by Umar *et al.* (2020) in Kano, Nigeria, where the majority of patients undergoing IVU were young and middle-aged adults. The age distribution may reflect greater exposure to environmental and occupational factors associated with urinary tract pathology, including dehydration, dietary influences, and recurrent urinary tract infections, which are recognized risk factors for stone disease in tropical regions (Sorokin *et al.*, 2017).

Sex Distribution

Of the 285 patient records reviewed, 204 (71.6%) were males and 81 (28.4%) were females, resulting in a male-to-female ratio of approximately 2.5:1 as shown in table 2.

Table 2: Sex Distribution of Patients

Sex	Frequency	Percentage (%)
Male	204	71.6
Female	81	28.4
Total	285	100.0

The marked male predominance observed in this study is consistent with the established epidemiological pattern of urinary tract disease, particularly urolithiasis. Similar male preponderance has been reported in studies conducted in Nigeria and other developing countries, where males constitute the majority of patients undergoing IVU examinations. Umar *et al.* (2020) reported a male predominance among patients evaluated with IVU in Kano, Nigeria, while Sorokin *et al.* (2017) noted that urinary stone disease is generally more common in males worldwide. Aklan and Mikhlafy (2018) also observed greater male representation in their IVU findings. Hormonal influences, occupational exposure to high temperatures, dehydration, and dietary factors have been implicated as contributing factors to the increased occurrence of urinary tract calculi among men. The findings of the present study therefore reflect the demographic pattern commonly observed in urinary tract imaging practice.

Clinical Indications for Intravenous Urography

The commonest indication for IVU was flank pain or suspected urinary tract obstruction, accounting for 33.7% of examinations. This was followed by suspected urinary calculi and haematuria, which accounted for 24.9% and 15.4%, respectively as shown in table 3.

Table 3: Clinical Indications for Intravenous Urography

Indication	Frequency	Percentage (%)
Flank pain/suspected obstruction	96	33.7
Suspected urinary calculi	71	24.9
Haematuria	44	15.4
Recurrent urinary tract infection	38	13.3
Congenital anomaly	17	6.0
Lower urinary tract symptoms	11	3.9
Others	8	2.8
Total	285	100.0

Flank pain or suspected urinary tract obstruction constituted the most frequent indication for IVU in the present study, followed by suspected urinary calculi and haematuria. This pattern reflects the continuing importance of IVU in the evaluation of obstructive uropathy and stone disease in resource-limited settings. The diagnostic value of IVU is influenced by the underlying clinical indication. Ogunbiyi and Nzeh (1984) demonstrated that IVU yielded a higher rate of abnormal findings in patients investigated for abdominal masses, posterior urethral valves, and hypertension, while lower diagnostic yields were observed in those evaluated for enuresis and non-specific abdominal pain. These findings highlight the importance of appropriate patient selection in optimizing the diagnostic utility of intravenous urography. Similar observations were reported by Umar *et al.* (2020), who found flank pain to be the leading indication for conventional IVU in a tertiary hospital in northern Nigeria. The predominance of obstructive symptoms among referred patients is unsurprising given the high burden of urinary stone disease in tropical regions. Although CT urography has become the preferred imaging modality in many developed healthcare systems, studies have shown that IVU continues to provide useful anatomical and functional information where access to advanced imaging remains limited (Whitfield & Whitfield, 2006). The continuing utilization of IVU in the present study reflects the realities of radiological practice in many parts of sub-Saharan Africa, where access to advanced imaging remains uneven. Kawooya (2012) noted that shortages of imaging infrastructure and trained personnel continue to affect diagnostic services across many African healthcare systems, thereby sustaining the relevance of conventional imaging modalities such as IVU.

Radiological Findings on Intravenous Urography

Hydronephrosis was the most frequent radiological finding, occurring in 78 (27.4%) examinations. Urinary calculi and hydroureter accounted for 22.5% and 13.7%, respectively, while only 8.4% of examinations were reported as normal as shown in table 4.

Table 4: Spectrum of Radiological Findings on Intravenous Urography

Radiological Finding	Frequency	Percentage (%)
Hydronephrosis	78	27.4
Urinary calculi	64	22.5
Hydroureter	39	13.7
Delayed contrast excretion	28	9.8
Non-functioning kidney	21	7.4
Congenital anomalies	17	6.0
Filling defects / Mass lesions	9	3.2
Normal findings	24	8.4
Others	5	1.8
Total	285	100.0

The predominance of hydronephrosis and urinary calculi observed in this study is consistent with findings from other resource-limited settings. Akagbue and Wekhe (2023) similarly reported hydronephrosis as the most common abnormality among patients undergoing IVU in Port Harcourt, Nigeria. Likewise, Aklan and Mikhlafy (2018) identified hydronephrosis and urinary calculi as the predominant abnormalities in a large retrospective review, while Umar *et al.* (2020) reported urinary calculi as the most frequent abnormal finding in northern Nigeria. The low proportion of normal examinations further suggests that most patients were appropriately selected for IVU, resulting in a high diagnostic yield. These observations highlight the continuing burden of obstructive uropathy and stone disease and underscore the diagnostic relevance of IVU where access to advanced imaging remains limited.

Association between Clinical Variables and Radiological Findings

There was a statistically significant association between sex and the presence of urinary calculi, with calculi occurring more frequently among males ($\chi^2 = 4.43$, df = 1, $p = 0.035$) as shown in table 5.

Table 5: Association between Sex and Urinary Calculi

Sex	Calculi present	Calculi absent	Total
Male	53	151	204
Female	11	70	81
Total	64	221	285

The significant association between male sex and urinary calculi agrees with the established epidemiology of stone disease. Sorokin et al. (2017) reported that urolithiasis is generally more common among males globally, while Umar et al. (2020) and Aklan and Mikhlafy (2018) also observed male preponderance among patients with IVU abnormalities. This may reflect occupational dehydration, high ambient temperature exposure, dietary factors, and biological differences in urinary stone risk. The implication is that sex-related risk profiling may improve clinical suspicion and imaging selection in patients presenting with symptoms suggestive of urinary calculi.

Association between Clinical Indications and Hydronephrosis

Hydronephrosis occurred significantly more frequently among patient records in which flank pain or suspected urinary tract obstruction was the clinical indication ($\chi^2 = 33.01$, $p < 0.001$) as shown in table 6.

Table 6: Association between Clinical Indications and Hydronephrosis

Clinical Indication	Hydronephrosis Present	Hydronephrosis Absent	Total
Flank pain/suspected obstruction	46	50	96
Suspected urinary calculi	16	55	71
Haematuria	5	39	44
Recurrent urinary tract infection	6	32	38
Congenital anomaly	3	14	17
Lower urinary tract symptoms	1	10	11
Others	1	7	8
Total	78	207	285

This significant association suggests good concordance between clinical suspicion and radiological diagnosis, particularly in patients referred for evaluation of obstructive urinary tract pathology. The finding is expected, as hydronephrosis commonly results from impaired urinary drainage and may present clinically with flank pain, especially when obstruction is acute or progressive. Similar IVU-based reports from Nigeria have documented hydronephrosis and obstructive uropathy among common radiological findings in patients evaluated for urinary tract symptoms (Umar *et al*., 2020; Akagbue & Wekhe, 2023). Dyer *et al.* (2001) emphasized that one of the major strengths of IVU is its ability to demonstrate the level and functional significance of urinary tract obstruction. The findings of the present study therefore support the continued use of IVU in evaluating patients with suspected obstructive uropathy where more advanced imaging modalities are unavailable.

Mean Age and Urinary Calculi

The mean age of patients with urinary calculi was significantly higher than that of patients without calculi (38.4 ± 13.2 years versus 34.9 ± 14.8 years; $t = 2.31$, $p = 0.022$), as shown in Table 7.

Table 7: Comparison of Mean Age between Patients with and Without Urinary Calculi

Group	Mean age ± SD (years)	t-value	p-value
Calculi present	38.4 ± 13.2	2.31	0.022
Calculi absent	34.9 ± 14.8		

Patients with urinary calculi were significantly older than those without calculi. This finding suggests that increasing age may be associated with a greater likelihood of stone formation among patients undergoing intravenous urography. The observed difference may be explained by the gradual and cumulative nature of urinary stone development, where prolonged exposure to factors such as dehydration, dietary habits, recurrent urinary tract infection, urinary stasis, and metabolic abnormalities may increase the risk of calculi over time. This is particularly relevant in settings where high environmental temperatures and delayed hospital presentation may contribute to prolonged dehydration and late detection of urinary tract pathology. Similar patterns have been reported in previous IVU-based studies in Nigeria, where urinary calculi and obstructive uropathy were commonly encountered among adult patients undergoing evaluation for urinary tract symptoms (Umar *et al*., 2020; Akagbue & Wekhe, 2023). This also agrees with broader epidemiological evidence showing that urolithiasis varies with age and remains an important cause of urinary tract morbidity among adults (Sorokin *et al*., 2017). In the present study, the higher mean age among patients with calculi may therefore reflect both the cumulative exposure to stone-forming risk factors and delayed presentation for radiological evaluation in a resource-limited setting.

Clinical Indications and Urinary Calculi

A statistically significant association was observed between clinical indication and the presence of urinary calculi ($\chi^2 = 25.81$, $p < 0.001$) as shown in table 8.

Table 8: Association between Clinical Indications and Urinary Calculi

Clinical indication	Calculi present	Calculi absent	Total
Flank pain/suspected obstruction	31	65	96
Suspected urinary calculi	24	47	71
Haematuria	4	40	44
Recurrent urinary tract infection	2	36	38
Congenital anomaly	1	16	17
Lower urinary tract symptoms	1	10	11
Others	1	7	8
Total	64	221	285

These results show that intravenous urography continues to provide valuable diagnostic information in settings where access to cross-sectional imaging remains limited, particularly for obstructive and stone-related pathology.

The significant relationship between clinical indications and the presence of urinary calculi demonstrates that clinical suspicion remains an important predictor of stone disease. Patients presenting with flank pain or suspected urinary calculi were significantly more likely to have radiologically confirmed stones than patients referred for other indications. This finding highlights the value of careful clinical assessment in guiding appropriate imaging requests and supports the continued diagnostic relevance of IVU in selected patient populations. Similar findings were reported by Umar *et al.* (2020), who identified flank pain as the leading indication for conventional IVU and urinary calculi as the

most frequent abnormal finding in northern Nigeria. Akagbue and Wekhe (2023) also documented obstructive and stone-related abnormalities among patients undergoing IVU in Port Harcourt. Although contemporary urinary tract imaging increasingly relies on CT-based techniques, IVU continues to provide valuable diagnostic information in healthcare environments where access to cross-sectional imaging remains limited. Whitfield and Whitfield (2006) observed that despite substantial advances in urinary tract imaging, IVU retains a role in specific clinical scenarios, particularly in settings where modern imaging resources are not readily available. The findings of the present study reinforce this perspective and demonstrate that IVU remains a useful diagnostic modality for evaluating suspected stone disease and obstructive uropathy in resource-constrained healthcare systems.

Overall, the findings of this retrospective study demonstrate that intravenous urography continues to provide clinically useful diagnostic information in the evaluation of urinary tract disorders within resource-limited healthcare environments. The predominance of hydronephrosis and urinary calculi, together with the significant associations observed between clinical presentation and radiological findings, highlights the continuing relevance of IVU in the assessment of obstructive uropathy and stone disease where access to advanced cross-sectional imaging remains constrained.

CONCLUSION

This six-year retrospective study demonstrated that intravenous urography remains a useful diagnostic modality for evaluating urinary tract disorders in a resource-limited tertiary healthcare setting. The examination was most frequently requested for suspected urinary tract obstruction, urinary calculi, and haematuria, while hydronephrosis, urinary calculi, and hydroureter were the predominant radiological findings. Significant associations between clinical presentation and radiological abnormalities highlight the continued diagnostic value of IVU in appropriately selected patients. Although advanced cross-sectional imaging techniques have become the standard in many healthcare systems, intravenous urography continues to provide clinically relevant anatomical and functional information in environments where access to such technologies remains limited. These findings underscore the continuing role of IVU in the evaluation of obstructive uropathy and stone disease in resource-constrained settings.

Efforts should be made to improve access to advanced imaging modalities, particularly computed tomography urography, in resource-limited healthcare settings to enhance the evaluation of urinary tract disorders.

Given the continuing diagnostic value demonstrated by intravenous urography in this study, conventional urographic services should be maintained where access to cross-sectional imaging remains constrained.

Public health interventions aimed at promoting adequate hydration, increasing awareness of urinary tract symptoms, and encouraging early presentation to healthcare facilities may help reduce the burden of obstructive uropathy and urolithiasis in the region.

Furthermore, multicentre studies involving tertiary healthcare institutions across different parts of Nigeria are recommended to assess contemporary patterns of IVU utilization, diagnostic yield, and the impact of increasing availability of advanced imaging technologies on clinical practice.

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